

Ground-living spiders in wooded habitats under human influence on an island in Finland

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Abstract. Spiders were collected by pitfall traps in the south-western archipelago of Finland. Wooded study habitats on a small-sized (1.2 km²) island were: 1) natural open ash grove, 2) dense mixed grove (old overgrown wooded meadow), 3) wooded aspen pasture and 4) wooded meadow, both restored ten years earlier, 5) natural wooded meadow. Highest species and family numbers were found at the natural sites (1 and 5) and the lowest in the dense grove (site 2). Linyphiidae dominated, both at species and individual level, in the groves. Lycosidae were abundant on the wooded meadows and Gnaphosidae on the wooded pasture. The highest faunal similarities were between the groves (70 % species in common) and between the wooded meadows (64 %). The lowest similarity was found between the dense grove (17 %) and the ash grove (23 %) with the aspen pasture. Ten years after clearing, sites 3 and 4 had diverse spider faunas. The fauna at site 4 resembled that on the corresponding natural site (5), thus showing restoration success. Altogether 84 species of spiders were caught. The proportion of Gnaphosidae (16 species found) is high. Most species found in the study are common in south-western Finland and many occur across the whole country. *Pardosa lugubris* was most dominant at three sites, *P. pullata* and *Diplostyla concolor* both at one site. Two species, *Enoplognatha thoracica* and *Micaria fulgens*, are included in the Finnish Red Data Book.

Keywords: Araneae, archipelago, groves, habitat restoration, wooded meadows, wooded pastures

The island group Jungfruskär comprises three island and a few small islets. It is situated in the south-western archipelago of Finland, between the Turku archipelago and the Åland archipelago in an open sound called Skiftet (Fig. 1). Jungfruskär is located in the north-westernmost corner of the South-western Archipelago National Park. Due to its exceptionally diverse flora and fauna it is known as “the flagship of the Park” (Lindgren 2000).

The islands have been used as grazing sites for sheep, goats and cows for a few hundred years. Around 1850 some permanent inhabitants were settled on Storlandet (the study island), and after that felling of trees, cutting of upper parts of deciduous trees (pollarding) for fodder, and grazing itself became more active. This human activity produced special semi-natural habitats, like wooded meadows and wooded pastures. **Wooded meadows** are situated on the most fertile soils. They are rather open: usually 15-25 % coverage by copses of deciduous trees and shrubs, the rest being open meadow. Grass vegetation is rather short (due to hay harvesting and grazing) and the sites are characterized by many flowering plants, like the orchid

Dactylorhiza sambucina. **Wooded pastures** are found on fertile, but more stony, sites. In addition, also forests, dry meadows and shores were used as pastures.

During the 1960s human activity diminished, and many wooded meadows and other pastures began to overgrow. Clearing and opening of shrub lands started by volunteers in the 1980s and later also by the staff of the National Park (Lindgren 2000). This restoration activity has been very effective.

The aim of this paper is to document the composition and differences of ground-living spider communities in habitats which have been under different level of human activity on Storlandet, the main island of Jungfruskär.

Study area, material and methods

Jungfruskär is isolated from larger, forest growing land masses (islands). Larger islands to the south-east, south-west and west lay ca. 20 km from Jungfruskär, and those to the east, north and north-west ca. 10 km apart. The distances to the Finnish, Swedish and Estonian mainland are 60, 120 and 170 km respectively. The land area of the Jungfruskär island group is ca. 2 km² and that of the main island Storlandet 1.2 km². Its geographic location is 60° 8.35'N, 21° 4.69'E.

The land elevation here, caused by the Ice Age, is about half a meter per century. Therefore the highest hills in the island are about 3000-4000 years old, and

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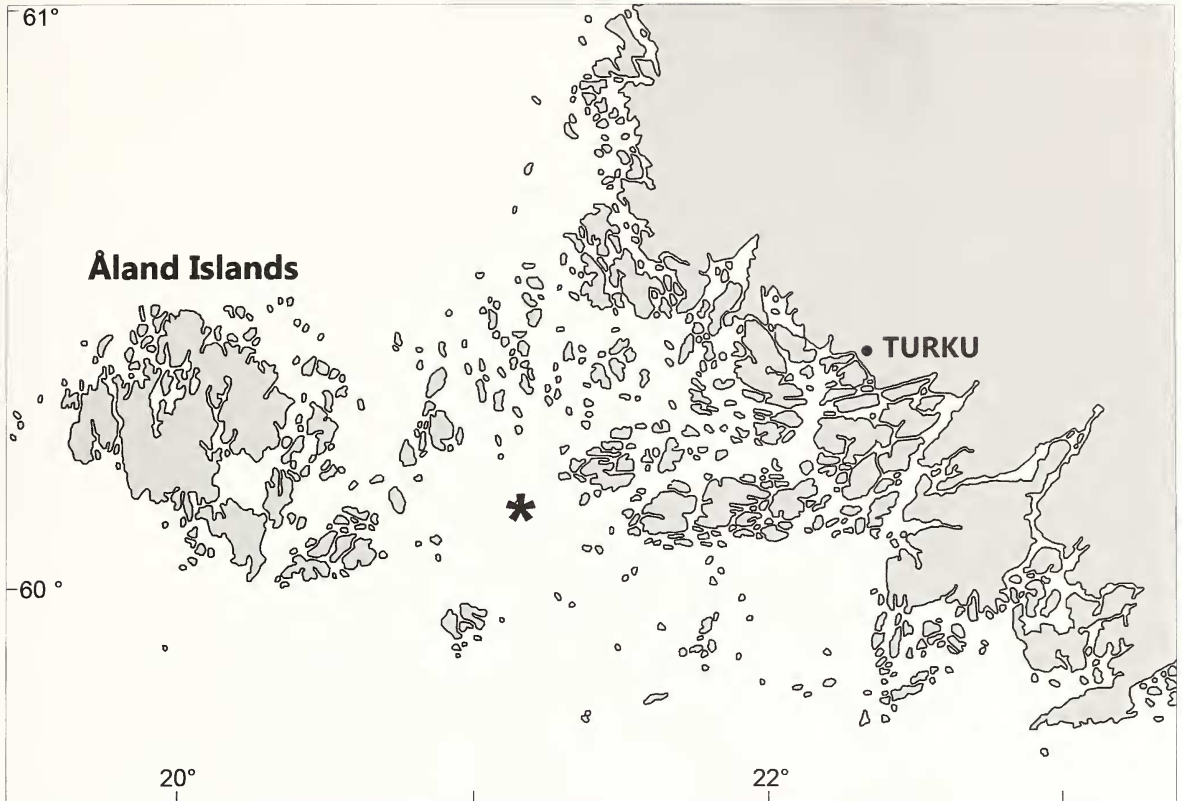


Fig. 1: The study island, Storlandet/Jungfruskär (*), in the SW archipelago of Finland.

the present study sites have been above sea level for about 400–1000 years.

Five wooded sites were studied on Storlandet. The elevation of the sites varied from 2 to 5 m a.s.l.

- 1) **Open ash grove** (natural). Trees: *Fraxinus excelsior* and *Alnus glutinosa*; abundant field layer plants: *Filipendula ulmaria*, *Urtica dioica*, *Anthriscus sylvestris* and *Allium scorodoprasum*.
- 2) **Mixed dense grove** (old overgrown wooded meadow), Fig. 2. Trees and shrubs: *Betula pubescens*, *Alnus glutinosa*, *Prunus padus*, *Viburnum opulus* and *Ribes alpinum*; field layer: *Milium effusum*, *Geum rivale*, *Filipendula ulmaria* and *Silene dioica*.
- 3) **Wooded aspen pasture** (junipers and coppice removed in 1997–98). Trees and shrubs: *Populus tremula* and *Ribes alpinum*; field layer: *Fragaria vesca*, *Rubus saxatilis*, *Primula veris* and different grasses. Also ground-laying rotten trunks of aspen. Before clearing it resembled site 2.
- 4) **Wooded meadow** (cleared in 1997–98). Trees: *Alnus glutinosa*, *Sorbus aucuparia* and *Prunus padus*; field layer: *Deschampsia cespitosa*, *Filipendula ul-*

maria, *Rubus idaeus*, *Geranium sylvaticum* and *Silene dioica*. Before clearing it resembled site 2.

- 5) **Wooded meadow** (natural) on calcareous moraine, Fig. 3. Trees: *Alnus glutinosa* and *Betula pubescens*; field layer: *Convallaria majalis*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Rhinanthus minor* and *Galium boreale*.

Ground-living spiders were collected using pitfall traps from 22 May to 11 September, 2007. Ten traps (diameter 6 cm, with propylene glycol and detergent, and covers) were placed at each site. Material consists of 1,299 adult, identifiable specimens, and is deposited in the Zoological Museum, University of Turku.

Results

Altogether, 84 species of spiders belonging to 12 families were caught by pitfall trapping (Tab. 1). The most species-rich families were Linyphiidae (41 species), Gnaphosidae (16), Lycosidae (9) and Thomisidae (7). The structure of the spider communities at the study sites is shown in Table 2. The highest

Tab. 1: Spider species collected in study habitats (sites 1-5) using pitfall traps, 2007.

site	1	2	3	4	5
Araneidae (1)					
<i>Zygiella atrica</i> (C. L. Koch, 1845)	.	1	.	.	.
Clubionidae (1)					
<i>Clubiona lutescens</i> Westring, 1851	2	.	.	.	.
Corinnidae (1)					
<i>Phrurolithus festivus</i> (C. L. Koch, 1835)	.	.	2	.	1
Gnaphosidae (16)					
<i>Callilepis nocturna</i> (Linnaeus, 1758)	.	.	2	.	.
<i>Drassodes pubescens</i> (Thorell, 1856)	.	.	4	1	.
<i>Drassyllus praeficus</i> (L. Koch, 1866)	.	.	7	.	.
<i>Drassyllus pusillus</i> (C. L. Koch, 1833)	.	.	2	.	8
<i>Gnaphosa bicolor</i> (Hahn, 1833)	.	.	8	.	.
<i>Haplodrassus signifer</i> (C. L. Koch, 1839)	.	.	6	2	.
<i>Haplodrassus silvestris</i> (Blackwall, 1833)	2	.	9	3	1
<i>Micaria aenea</i> Thorell, 1871	.	.	22	.	.
<i>Micaria fulgens</i> (Walckenaer, 1802)	.	.	1	.	.
<i>Micaria pulicaria</i> (Sundevall, 1831)	.	.	5	2	.
<i>Micaria subopaca</i> Westring, 1861	.	.	.	.	1
<i>Zelotes clivicola</i> (L. Koch, 1870)	.	.	1	.	.
<i>Zelotes latreillei</i> (Simon, 1878)	1	.	16	1	2
<i>Zelotes longipes</i> (L. Koch, 1866)	.	.	.	1	1
<i>Zelotes petrensis</i> (C. L. Koch, 1839)	.	.	11	.	.
<i>Zelotes subterraneus</i> (C. L. Koch, 1833)	4	.	.	.	.
Linyphiidae (41)					
<i>Agynphantes expunctus</i> (O. P.-Cambridge, 1875)	.	.	.	1	.
<i>Agyneta affinis</i> (Kulczyński, 1898)	.	.	3	.	2
<i>Agyneta conigera</i> (O. P.-Cambridge, 1863)	1	.	.	.	.
<i>Agyneta ramosa</i> Jackson, 1912	2	15	.	.	1
<i>Agyneta subtilis</i> (O. P.-Cambridge, 1863)	2	1	.	.	.
<i>Allomengea scopigera</i> (Grube, 1859)	1	.	.	.	.
<i>Anguliphantes angulipalpis</i> (Westring, 1851)	2	1	.	.	.
<i>Bathypantes gracilis</i> (Blackwall, 1841)	.	.	.	1	11
<i>Bathypantes nigrinus</i> (Westring, 1851)	.	.	.	1	.
<i>Bathypantes parvulus</i> (Westring, 1851)	.	3	.	6	.
<i>Centromerus arcanus</i> (O. P.-Cambridge, 1873)	.	1	.	.	.
<i>Ceratinella brevis</i> (Wider, 1834)	2	1	3	2	1.
<i>Ceratinella scabrosa</i> (O. P.-Cambridge, 1871)	16	.	.	.	.
* <i>Dicymbium nigrum</i> (Blackwall, 1834)	33	4	.	6	5
<i>Diplocephalus picinus</i> (Blackwall, 1841)	16	5	.	.	1
<i>Diplostyla concolor</i> (Wider, 1834)	3	67	1	.	3
<i>Erigone atra</i> Blackwall, 1833	2	.	.	.	3
<i>Erigonella biemalis</i> (Blackwall, 1841)	.	.	.	3	.
<i>Gonatium rubens</i> (Blackwall, 1833)	1	.	.	.	.
<i>Gongylidiellum latebricola</i> (O. P.-Cambridge, 1871)	.	.	.	.	1
<i>Gongylidium rufipes</i> (Linnaeus, 1758)	4	.	.	.	.
<i>Macrargus carpenteri</i> (O. P.-Cambridge, 1894)	.	.	1	.	.
<i>Macrargus rufus</i> (Wider, 1834)	4	.	.	.	.
<i>Maro minutus</i> O. P.-Cambridge, 1906	.	1	.	.	.
<i>Maso sundevalli</i> (Westring, 1851)	.	.	.	.	1

site	1	2	3	4	5
<i>Micrargus herbigradus</i> (Blackwall, 1854)	.	2	.	.	.
<i>Microneta viaria</i> (Blackwall, 1841)	.	3	.	.	.
<i>Panamomops menzei</i> Simon, 1926	.	.	1	.	.
<i>Porrhomma pallidum</i> Jackson, 1913	1	2	.	.	.
<i>Tapinocyba pallens</i> (O. P.-Cambridge, 1872)	4	9	.	.	.
<i>Tapinocyboides pygmaea</i> (Menge, 1869)	.	.	.	.	2
<i>Tapinopa longidens</i> (Wider, 1834)	2	.	.	.	.
<i>Tenuiphantes menzei</i> (Kulczyński, 1887)	1	.	.	.	.
<i>Tenuiphantes tenebricola</i> (Wider, 1834)	17	27	.	.	.
<i>Tiso vagans</i> (Blackwall, 1834)	16	.	.	39	11
<i>Walckenaeria antica</i> (Wider, 1834)	.	.	2	.	.
<i>Walckenaeria atrotibialis</i> (O. P.-Cambridge, 1878)	6	21	.	3	3
<i>Walckenaeria cucullata</i> (C. L. Koch, 1836)	3	2	.	.	1
<i>Walckenaeria dysderoides</i> (Wider, 1834)	.	.	1	.	.
<i>Walckenaeria unicornis</i> O. P.-Cambridge, 1861	1	.	.	.	.
<i>Walckenaeria vigilax</i> O. P.-Cambridge, 1861	1	.	.	1	1
Lycosidae (9)					
<i>Alopecosa pulverulenta</i> (Clerck, 1757)	4	.	62	.	2
<i>Alopecosa taeniata</i> (C. L. Koch, 1835)	.	.	1	1	.
<i>Pardosa fulvipes</i> (Collett, 1876)	8	.	.	.	9
<i>Pardosa lugubris</i> (Walckenaer, 1802)	88	4	72	81	12
<i>Pardosa palustris</i> (Linnaeus, 1758)	.	.	1	.	7
<i>Pardosa prativaga</i> (L. Koch, 1870)	1	.	.	.	1
<i>Pardosa pullata</i> (Clerck, 1757)	.	.	.	1	40
<i>Trochosa spinipalpis</i> (F. O. P.-Cambridge, 1895)	.	.	.	6	7
<i>Trochosa terricola</i> Thorell, 1856	17	2	48	47	24
Salticidae (1)					
<i>Neon reticulatus</i> (Blackwall, 1853)	1	.	.	.	.
Segestriidae (1)					
<i>Segestria senoculata</i> (Linnaeus, 1758)	1	.	.	.	.
Tetragnathidae (2)					
<i>Pachygnatha degeeri</i> Sundevall, 1830	.	.	47	11	25
<i>Pachygnatha listeri</i> Sundevall, 1830	19	11	.	2	.
Theridiidae (3)					
<i>Enoplognatha thoracica</i> (Hahn, 1833)	.	.	.	1	1
<i>Euryopis flavomaculata</i> (C. L. Koch, 1836)	.	.	8	.	.
<i>Robertus lividus</i> (Blackwall, 1836)	1	.	.	.	.
Thomisidae (7)					
<i>Ozyptila atomaria</i> (Panzer, 1801)	.	.	.	.	3
<i>Ozyptila praticola</i> (C. L. Koch, 1837)	32	8	.	1	3
<i>Ozyptila trux</i> (Blackwall, 1846)	.	3	.	.	2
<i>Xysticus bifasciatus</i> C. L. Koch, 1837	.	.	1	.	.
<i>Xysticus cristatus</i> (Clerck, 1757)	.	.	.	.	4
<i>Xysticus erraticus</i> (Blackwall, 1834)	.	.	.	.	1
<i>Xysticus obscurus</i> Collett, 1877	.	.	.	.	5
Zoridae (1)					
<i>Zora spinimana</i> (Sundevall, 1833)	.	.	3	.	1
Total specimens	322	194	351	224	208
Total species	38	23	30	25	38

* editor's comment: only *Dicymbium nigrum brevisetosum* Locket, 1962 is known from Scandinavia

species and family numbers were found in the most natural sites (1 and 5), and smallest numbers in the dense, shady mixed grove (2). Clear differences were found in the family composition between sites. Linyphiidae clearly dominated, both at species and individual level, in the two studied groves. Lycosidae were most abundant on the two wooded meadows and Gnaphosidae on the wooded pasture (Tab. 2).

The six most abundant spider species at each site are listed in Tab. 3. Among the ten most abundant species in the groves (sites 1 and 2), the following six were shared in common: *Pardosa lugubris*, *Dicymbium nigrum*, *Ozyptila praticola*, *Pachygnatha listeri*, *Tenuiphantes tenebricola* and *Diplocephalus picinus*. Three species, *Pardosa lugubris*, *Pachygnatha degeeri* and *Trochosa terricola*, were among the top-ten at all three more open sites (3-5: wooded pasture and wooded meadows). In addition, *Haplodrassus silvestris*, *Tiso vagans* and *Trochosa spinipalpis* were abundant at two sites, i.e. in wooded meadows (sites 4 and 5). Dealing with all five habitats, a *Pardosa* species was the most dominant at four sites (*P. lugubris* at three and *P. pullata* once), and *Diplostyla concolor* in the dense grove. Species with high numbers at many sites also

include *Pachygnatha degeeri* and *Trochosa terricola*. Interestingly, only one species (*Pardosa lugubris*) was common in the top-ten lists of the mixed grove and wooded ash pasture. These are rather closely situated sites, and a decade prior to trapping (i.e. before restoration work) the wooded pasture was rather similar to the mixed grove. Only three of the total 84 species, *Ceratinella brevis*, *Pardosa lugubris* and *Trochosa terricola*, were caught at all five study localities.

Faunal similarity between the study sites is shown in Tab. 4. The highest similarity is between the two groves (Sørensen index: 0.52) and two wooded meadows (0.51), the smallest similarity to others is seen in the wooded aspen pasture: with mixed grove (0.15) and with ash grove (0.21). Interestingly, the mixed grove has low species similarity with wooded aspen pasture and wooded cleared meadow. Before restoration, i.e. ten years prior to trapping, the nature of these three sites resembled each other.

Discussion

The proportion of Gnaphosidae among the study material is high, especially in terms of species numbers. Altogether, 16 gnaphosid species were found, i.e. 19 % of the total species. For comparison, only 7 % of the Finnish spider fauna belongs to Gnaphosidae (Koponen 2008a). Reasons for the large number of Gnaphosidae are open and warm habitats as well as the situation of Jungfruskär in the southernmost part of Finland. High numbers of Gnaphosidae species and specimens have also been found previously on dry and open island habitats in the south-western Finnish archipelago (e.g. Koponen 2000, 2008b).

Ten years after restoration work, i.e. the clearing of sites 3 and 4, their spider fauna was rich and clearly different (both at species and family level) from the fauna found in their original habitat type (site 2). Very probably the openness (more light and warmth in summertime) is the key factor for a new faunal composition of the restored sites 3 and 4. The fauna of the cleared wooded meadow (site 4) clearly resembled that of the more natural wooded meadow (site 5). At least here, the restoration work has thus been successful. Although some studies on differences in spider communities during woodland restoration have been done (e.g. Ryndock et al. 2012), there seems to be no comparable data known from adjacent countries.

One of the species discovered, *Enoplognatha thoracica*, has been listed as a vulnerable species (VU)

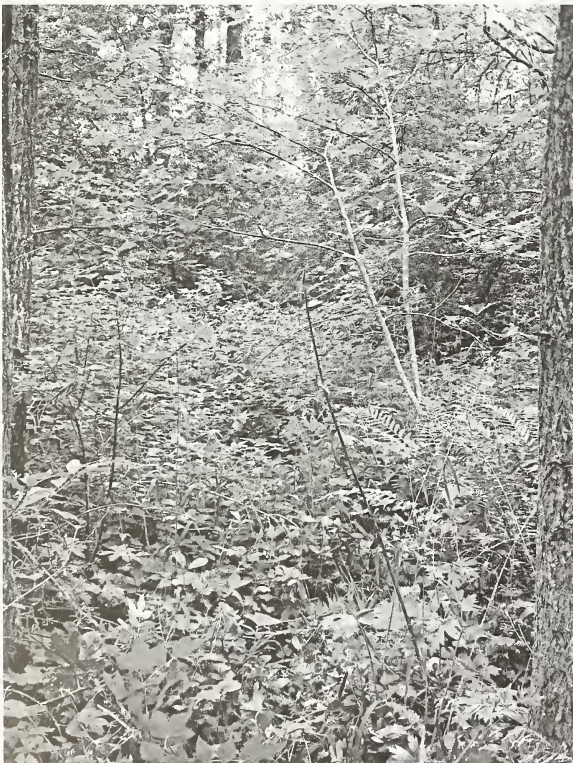


Fig. 2: Mixed dense grove (site 2). – Photo: V. Rinne 2007



Fig. 3: Wooded meadow (site 5).
– Photo: V. Rinne 2007

in the recent Finnish Red Data Book (Pajunen et al. 2010). Jungfruskär (where the species was found on both wooded meadows) represents its third locality in Finland. In addition, *Micaria fulgens*, found in wooded aspen pasture, is listed as NT (nearly threatened) in the Red Data Book.

In general, the spider fauna found on Jungfruskär is typical for the south-western archipelago of Finland (cf. Koponen 2008b). Species with a general southerly distribution dominated. Thus the record

of *Xysticus obscurus*, known in Finland as a northern or boreal species, is interesting. Koponen (2008b) studied ground-living spiders in groves on two islands ca. 35 km east of Jungfruskär. Among the most abundant species in groves both on Jungfruskär, and on these eastern islands, were e.g. *Diplostyla concolor*, *Pardosa lugubris* and *Tenuiphantes tenebricola*. Some species, like the linyphiids *Dicymbium nigrum* and *Tiso vagans*, were found in high numbers on Storlandet in Jungfruskär compared to earlier studies done

Tab. 2: The structure of spider communities. Sites 1) natural open ash grove, 2) mixed dense grove, 3) wooded aspen pasture, 4) wooded meadow, 5) natural wooded meadow.

Site	1	2	3	4	5
Species	38	23	30	25	38
Families	9	5	8	6	8
Specimens	322	194	351	224	208
Species (%) of total					
Linyphiidae	63.2	73.9	23.3	40.0	39.5
Lycosidae	13.2	8.7	16.7	20.0	21.0
Gnaphosidae	7.9	0	43.3	24.0	13.2
Thomisidae	2.6	8.7	3.3	5.0	15.8
Individuals (%) of total					
Linyphiidae	43.8	85.1	3.4	28.1	22.6
Lycosidae	36.6	3.1	52.4	60.7	49.0
Gnaphosidae	2.2	0	26.8	4.5	6.3
Thomisidae	9.9	5.7	0.3	0.5	8.7

Tab. 3: Six most abundant spider species in the 5 sites.

Study site	%
1) Open ash grove	
<i>Pardosa lugubris</i>	27.3
<i>Dicymbium nigrum</i>	10.2
<i>Ozyptila praticola</i>	9.9
<i>Pachygnatha listeri</i>	5.9
<i>Tenuiphantes tenebricola</i>	5.3
<i>Trochosa terricola</i>	5.3
2) Mixed dense grove	
<i>Diplostyla concolor</i>	34.5
<i>Tenuiphantes tenebricola</i>	13.9
<i>Walckenaeria atrotibialis</i>	10.8
<i>Agynera ramosa</i>	7.7
<i>Pachygnatha listeri</i>	5.7
<i>Tapinocyba pallens</i>	4.6
3) Wooded aspen pasture	
<i>Pardosa lugubris</i>	20.5
<i>Alopecosa pulverulenta</i>	17.7
<i>Trochosa terricola</i>	13.7
<i>Pachygnatha degeeri</i>	13.4
<i>Micaria aenea</i>	6.3
<i>Zelotes latreillei</i>	4.6
4) Wooded meadow	
<i>Pardosa lugubris</i>	36.2
<i>Trochosa terricola</i>	21.9
<i>Tiso vagans</i>	17.4
<i>Pachygnatha degeeri</i>	4.9
<i>Bathypantes parvulus</i>	2.7
<i>Dicymbium nigrum</i>	2.7
5) natural wooded meadow	
<i>Pardosa pullata</i>	19.2
<i>Pachygnatha degeeri</i>	12.0
<i>Trochosa terricola</i>	1.5
<i>Pardosa lugubris</i>	5.8
<i>Bathypantes gracilis</i>	5.3
<i>Tiso vagans</i>	5.3

in the archipelago (Lehtinen et al. 1979, Clayhills et al. 2000, Koponen 2000, 2008b). The present material consists of 84 species, but the total number of spiders recorded from the small (1.2 km²) island of Storlandet in the rather isolated Jungfruskär island group is as high as 167 (Clayhills et al. 2008). It is more than one fourth of the known Finnish spider fauna (Koponen 2008a).

Tab. 4: Similarity between study sites (Sørensen index).

Sites	1	2	3	4	5
1	-	0.52	0.21	0.38	0.45
2		-	0.15	0.33	0.33
3			-	0.36	0.35
4				-	0.51
5					-

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